Appendix C

Risk Assessment Review of COU, POU, and OU3

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C1.0 Introduction

This appendix presents the methodology for reviewing and evaluating changes to chemical and radiological risk assessment parameters that took effect during this FYR period and details the results of the risk assessment evaluation. The methodology used for this evaluation is based on the methodology used for the comprehensive risk assessment (CRA) completed in 2006. The CRA included a human health and ecological risk assessment for the COU and POU; a separate risk assessment was completed for OU3 (DOE 1997). A summary of the CRA may be found in the Third FYR report (DOE, 2012) and the complete CRA is found as an appendix to the RI/FS Report (DOE 2006).

The changes to risk assessment factors were evaluated for the COU, POU, and OU3 to determine if these changes have an impact to the risks presented by residual contamination left on site. Although the POU and OU3 have been deleted from the National Priorities List (NPL), a review of changes to risk assessment factors is required to determine if the UU/UE designation is still valid at both OUs.

C2.0 Central and Peripheral Operable Units

In the RI/FS Report (DOE 2006), the nature and extent of residual contamination in soil and sediment were evaluated after completion of the RFCA accelerated actions. Each nature and extent of contamination evaluation identified analytes of interest (AOIs). AOIs are chemicals that have been detected at concentrations that may contribute to the risk to future receptors. The evaluation studied the extent of sitewide contaminants and evaluated which chemicals remained after the completed accelerated actions. The soil AOIs identified in the RI/FS Report are presented in Table C-1.

In 2006, a comprehensive risk assessment was completed for the Rocky Flats Site to quantify the risk of residual contamination remaining after accelerated cleanup actions at the site (DOE 2006). The CRA was conducted in accordance with the EPA- and CDPHE-approved *Comprehensive Risk Assessment Work Plan and Methodology* (DOE 2005c). Calculations and conclusions in the CRA were based on post-remediation data; that is, data collected after the completion of all RFCA accelerated actions. To facilitate the CRA, the Site was divided into the twelve exposure units (EUs) shown in Figure C-1. The basic methodology for conducting human health risk assessments, as described in the *Risk Assessment Guidance for Superfund* (EPA 1989), has not changed since the CRA was completed.

C2.1 Risk Definitions

This section presents the definitions of key risk terms used throughout this appendix.

95 percent upper confidence limit (95UCL): This is statistical upper bound estimate of the mean for a set of samples and is a conservative measure of the average concentration. As a general rule, EPA recommends use of the 95UCL as the exposure point concentration for soils at a site (EPA 2002).

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Cancer risk: Presents the added probability of an individual or population of developing cancer during a lifetime as a result of exposure to site contaminants. The acceptable risk range for CERCLA sites is an added risk of less than 1 in 1,000,000 (1×10^{-6}) to a maximum of 1 in 10,000 (1×10^{-4}).

Hazard quotient: The ratio of the exposure level of a single substance to an acceptable noncarcinogenic toxicity value. If multiple substances are present, hazard quotients are summed in a hazard index. For CERCLA sites, the maximum acceptable hazard index is 1.0.

Maximum detected concentration (MDC): Maximum concentration detected in any soil sample a given constituent and exposure unit.

Table C-1. Soil AOIs identified in the RI/FS

Surface Soil (0–0.5 ft)	Subsurface Soil (0.5–8 ft)	Subsurface Soil (>8 ft)
Radionuclides		
Americium-241 Plutonium-239/240 Uranium-233/234 Uranium-235 Uranium-238	Americium-241 Plutonium-239/240 Uranium-235 Uranium-238	Plutonium-239/240
Metals		
Aluminum Arsenic Chromium (Total) Vanadium	Chromium (Total) Lead	
Volatile Organic Compounds (VOCs)		
	Tetrachloroethene	1,1,2,2-Tetrachloroethane CarbonTetrachloride Chloroform Methylene Chloride Tetrachloroethene Trichloroethene
Semivolatile Organic Compounds (SVOCs)		
Benzo(a)pyrene Dibenz(a,h)anthracene	Benzo(a)pyrene	Benzo(a)pyrene
Polychlorinated Biphenyls (PCBs)		
Aroclor-1254 Aroclor-1260 2,3,7,8-TCDD TEQ		Aroclor-1260

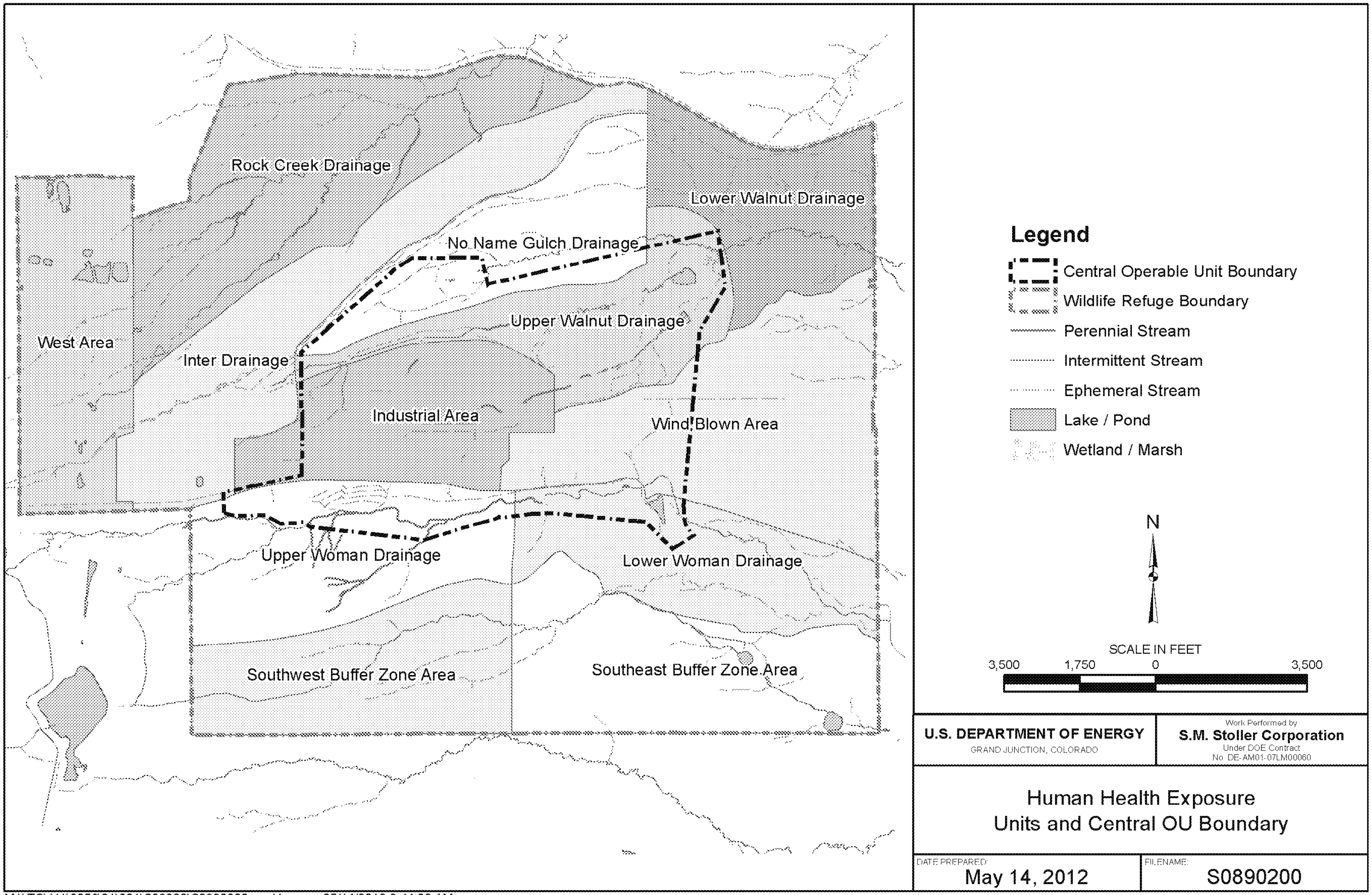

Figure C-1. Human Health Exposure Units and Central OU Boundary

C2.2 CRA Review Methodology

As an initial step in the CRA process, residual concentrations of constituents in soil for each EU were compared to preliminary remediation goals (PRGs) developed for a wildlife refuge worker (WRW). The PRGs represent concentrations for individual chemicals that would equate to a carcinogenic risk of 1×1^{-6} or a noncarcinogenic hazard quotient of 0.1 based on the exposure assumptions for the WRW. The 2006 CRA used a hazard quotient of 0.1 as an initial, conservative screening level; a hazard quotient of 1.0 is the maximum permissible limit. The PRGs were developed using toxicity data that were current at the time of the CRA and were developed for exposures to both surface and subsurface soils. PRGs for subsurface soils are higher than those for surface soils as it was assumed that the exposure frequency would be much lower (20 days per year compared to 230 days per year). The MDC for each detected constituent at each EU was compared to its respective PRG. If the MDC was less than the PRG, the constituent was eliminated from further consideration. If the MDC exceeded the PRG, the 95UCL of the mean for that constituent was compared to the PRG. If the 95UCL was less than the PRG, the constituent was eliminated from further consideration. If the 95UCL exceeded the PRG, the constituent was further evaluated based on frequency of detection, comparison to background concentrations, and professional judgement. Constituents passing through these remaining screening criteria were identified as COCs for each EU (Table C-2) and were further evaluated in the CRA. (Note that the sitewide AOI screening process and CRA EU-specific COC screening process were somewhat different and produced different results.) In the 2006 CRA, COCs were only identified for surface soils. All constituents in subsurface soils were eliminated by the 95UCL screen and no quantitative risks were calculated.

Table C-2. Surface Soil COCs Identified for Each EU in the CRA

Constituent	Exposure Unit											
	IAEU	UWOEU	WBEU	NNEU	UWNEU	LWOEU	RCEU	LWNEU	IDEU	WAEU	SWEU	SEEU
Arsenic	X		X									
Vanadium				X								
2,3,7,8-TCDD		X										
Benzo[a]pyrene	X	X			X							
Plutonium 239/240		X										

"X" means constituent was designated as a COC in the 2006 CRA.

C2.3 FYR Risk Assessment Review Methodology

Because the first two steps of the COC screening process in the CRA relied on a comparison of residual soil concentrations with the WRW PRGs, any subsequent changes to exposure assumptions or toxicity values used to calculate the PRGs could change the outcome of the screening process. For this FYR risk assessment review, a methodology similar to that described above for the CRA was applied to determine the impact of changes to risk assessment parameters for surface soils. Figure C-2 presents the screening methodology. In lieu of recalculating site-specific PRGs for a WRW, this FYR evaluation utilized the EPA regional screening levels

(RSLs) for industrial soil as starting point for contaminant screening. The RSLs incorporate current toxicity data and methodologies for the same exposure pathways of concern for the WRW. The default exposure assumptions for the industrial soil scenario are very similar to those used for the WRW for surface soils. Table C-3 compares the key assumptions used in RSL and site-specific PRG calculations. Where exposure factors are not the same, those used by EPA tend to be more conservative (i.e., assume a greater degree of exposure). Therefore it was determined that the EPA industrial soil RSLs were an acceptable screening tool to use for comparison to the surface soil WRW PRGs.

The complete list of surface soil WRW PRGs developed for the CRA were compared to current EPA industrial soil RSLs (EPA 2016). Of the more than 200 PRGs that were evaluated, slightly more than half were higher than the current RSL values. The vast majority of the lower RSL values were organic chemicals and many are considered to be volatile organic compounds (VOCs). EPA has recently finalized guidance on vapor intrusion (EPA 2015) and as a result has updated information on many VOCs included in their RSL tables. Additionally, the EPA approach to evaluating risks for the inhalation pathway was finalized in 2009. The methodology used in the CRA reflects older guidance for estimating exposures for this pathway. It is likely that a combination of these factors explain why such a large number of the WRW PRGs are higher than current RSLs. Decreases for most constituents were within an order of magnitude, but RSLs for a few constituents are several orders of magnitude lower than PRGs (e.g., cyclohexane).

Where PRGs were lower than current RSLs, it was assumed that results of the original screening process are still valid. Where RSLs were lower than PRGs, a rescreening of the EU statistical data was performed. EPA RSLs that were lower than PRGs were compared to data presented in the CRA for each EU. The analytical data (MDCs and 95UCL values) used in this FYR review are the same data used in the 2006 CRA; no new data was collected to support this FYR review. The MDCs and 95UCLs used in the surface soil screening were compared to the RSLs. If 95UCL data were not already tabulated, a 95UCL was calculated from statistical data provided in the CRA. If MDCs or 95UCLs were lower than the current RSLs, constituents were eliminated from further consideration. All other constituents were retained for further evaluation. Table C-4 presents the results of the chemical screening process by EU; Table C-5 summarizes the screening process by constituent name.

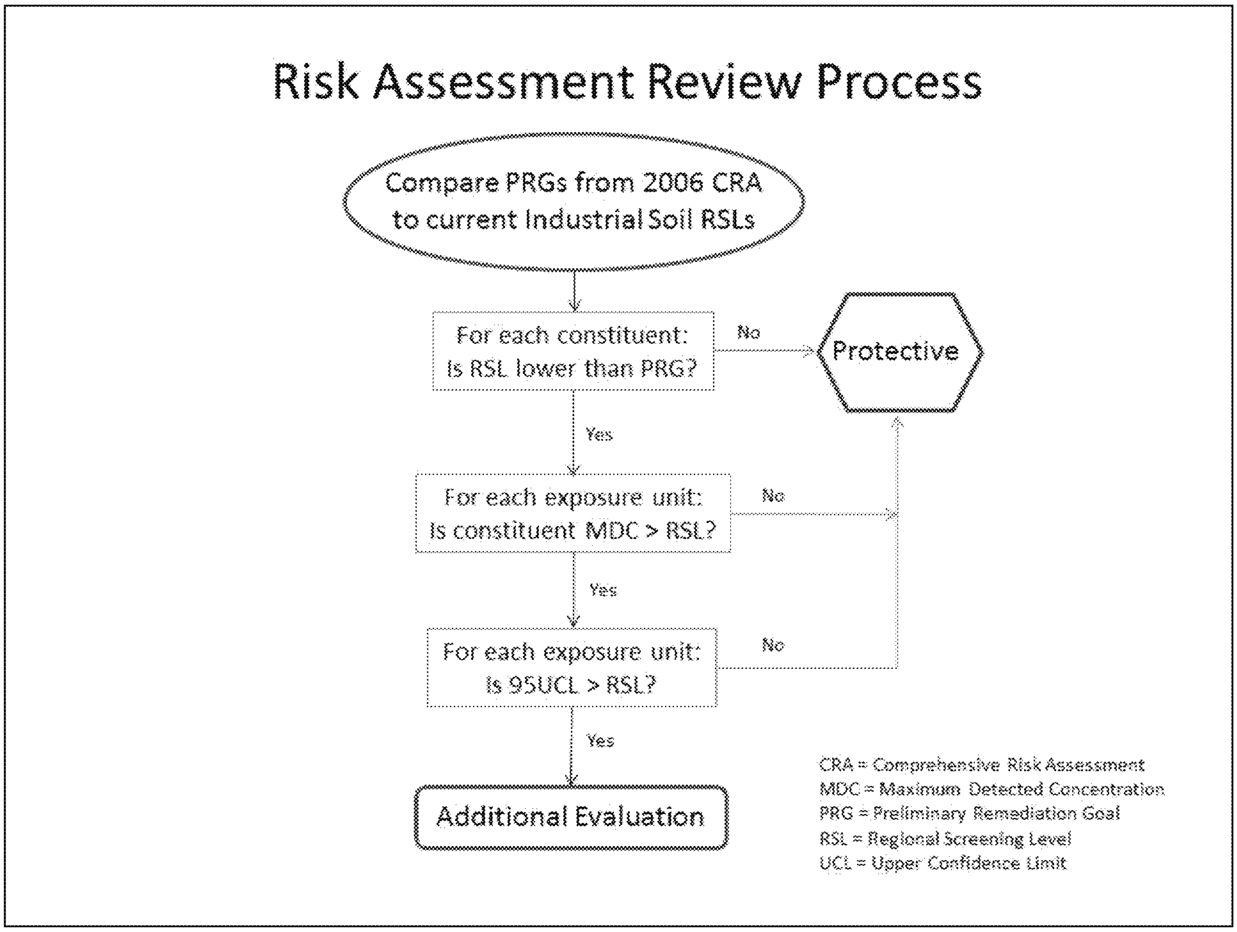

Figure C-2. Risk Assessment Review Process

Table C-3. Comparison of key exposure assumptions for RSLs and PRGs

Exposure Factor (units)	EPA RSL default value	WRW PRG assumption
Frequency of exposure (days/yr)	250	Surface soils—230 Subsurface soils--20
Exposure duration (years)	25	18.7
Exposure time (hr/day)	8	8
Soil ingestion rate (mg/day)	100	100
Adult body weight (kg)	80	70
Skin surface area (cm^2)	3527	3300

Table C-4. Surface Soil Chemical Constituent Screening Results by EU

Constituent	IAEU	UWOEU	WBEU	NNEU	UWNEU	LWOEU	RCEU	LWNEU	IDEU	WAEU	SWEU	SEEU
Arsenic	X		X									
Vanadium				X								
2,3,7,8-TCDD		X										
Aroclor 1254	X		X	X								
Aroclor 1260	X											
Benz[a]anthracene	X	X										
Benzo[a]pyrene	X	X	X	X	X							
Benzo[b]fluoranthene	X	X										
Chromium (VI)	X	X	X	X	X	X	X	X	X	X	X	X
Cobalt	X											
Diben[a,h]anthracene	X	X										
Indeno[1,2,3-cd]pyrene		X										
Lead and Compounds				X								
Mercury (elemental)	X											
Naphthalene		X										
Nitroso-di-N-propylamine, N-			X									
Uranium (Soluble Salts)	X	X										

"X" indicates MDC > EPA RSL
Shaded boxes indicate 95UCL > EPA RSL
Arsenic and vanadium were included in this table because they were identified as COCs in the CRA and 95UCL exceeds WRW PRG.

Table C-5. Surface Soil Chemical Constituent Screening Results by Constituent

All Constituents with PRGs	Constituents where EPA RSL < PRG	Constituents where EPA RSL < PRG (any EU)	Constituents where MDC > EPA RSL (any EU)
Acenaphthene	1,1,1-Trichloroethane,	1,1,1-Trichloroethane,	2,3,7,8-TCDD,
Acenapthylene	1,1,2,2-Tetrachloroethane,	1,1,2,2-	~Aroclor 1254
Acetone	1,1,2-Trichloro-1,2,2-	Tetrachloroethane,	~Aroclor 1260
Acrolein	trifluoroethane,	1,1,2-Trichloro-1,2,2-	Benz[a]anthracene
Acrylonitrile	1,1,2-Trichloroethane,	trifluoroethane,	Benzo[a]pyrene
Alachlor	1,1-Dichloroethane,	1,2,3-Trichloropropane,	Benzo[b]fluoranthene
Aldicarb	1,2,3-Trichloropropane,	1,2,4-Trichlorobenzene,	Chromium(VI)
Aldicarb Sulfone	1,2,4-Trichlorobenzene,	1,2-Dichloropropane,	Cobalt
Aldicarb sulfoxide	1,2-Dibromo-3-	2,4,6-Trichlorophenol,	~Dibenz[a,h]anthracene
Aldrin	chloropropane	2,4-Dimethylphenol,	~Indeno[1,2,3-cd]pyrene
Aluminum	1,2-Dichlorobenzene,	2,4-Dinitrophenol,	~Lead and Compounds
Ammonia	1,2-Dichloroethane,	2,3,7,8-TCDD,	~Mercury (elemental)
~Anthracene	1,2-Dichloropropane,	2-Butanone (Methyl Ethyl	~Naphthalene
Antimony (metallic)	1,2-Diphenylhydrazine,	Ketone)	Nitroso-di-N-
~Aroclor 1016	1,4-Dioxane,	2-Methylnaphthalene,	propylamine, N-
~Aroclor 1221	2,4,6-Trichlorophenol,	4-methyl-2-pentanone	Uranium (Soluble Salts)
~Aroclor 1232	2,4-Dimethylphenol,	(Methyl Isobutyl Ketone)	
~Aroclor 1242	2,4-Dinitrophenol,	Acetone	
~Aroclor 1248	2,4-Dinitrotoluene,	~Aroclor 1242	
~Aroclor 1254	2,6-Dinitrotoluene,	~Aroclor 1248	
~Aroclor 1260	2,3,7,8-TCDD,	~Aroclor 1254	
Arsenic, Inorganic	2-Butanone (Methyl Ethyl	~Aroclor 1260	
Atrazine	Ketone)	Benzene	
Barium	2-Chloronaphthalene (Beta-)	Benz[a]anthracene	
Benzene	2-Methylnaphthalene,	Benzo[a]pyrene	
Benzidine	3,3'-Dichlorobenzidine,	Benzo[b]fluoranthene	
~Benz[a]anthracene	4,6-Dinitro-o-cresol,	Benzo[k]fluoranthene	
~Benzo[a]pyrene	4-Chloroaniline	Benzyl Alcohol	
~Benzo[b]fluoranthene	4-methyl-2-pentanone	Bis(2-ethylhexyl)phthalate	
~Benzo[g,h,i]perylene	(Methyl Isobutyl Ketone)	Bromodichloromethane	
~Benzo[k]fluoranthene	4-Nitroaniline,	Bromomethane	
Benzoic Acid	Acetone	Butyl Benzyl Phthalate	
Benzyl Alcohol	Acrolein	Carbon Disulfide	
Beryllium and compounds	Acrylonitrile	Carbon Tetrachloride	
Bis(2-chloroethyl)ether	~Aroclor 1221	Chlorobenzene	
Bis(2-chloro-1-methylethyl)	~Aroclor 1232	Chloroform	
ether	~Aroclor 1242	Chloromethane (methyl	
Bis(2-ethylhexyl)phthalate	~Aroclor 1248	chloride)	
Boron And Borates Only	~Aroclor 1254	Chromium(VI)	
Bromodichloromethane	~Aroclor 1260	Chrysene	
Bromoform	Atrazine	Cobalt	
Bromomethane	Benzene	DDD	
2-Butanone (Methyl Ethyl	Benzidine	DDE, p,p'-	
Ketone)	Benz[a]anthracene	DDT	
Butyl Benzyl Phthalate	Benzo[a]pyrene	~Dibenz[a,h]anthracene	
Cadmium (Diet)	Benzo[b]fluoranthene	Dibenzofuran	
Carbazole	Benzo[k]fluoranthene	Dieldrin	
Carbofuran	Benzyl Alcohol	Dimethylphthalate	
Carbon Disulfide	Bis(2-chloroethyl)ether	di-N-Octyl Phthalate	
Carbon Tetrachloride	Bis(2-ethylhexyl)phthalate	Ethylbenzene	
Chlordane-alpha	Bromodichloromethane	~Fluorene	
Chlordane-beta	Bromoform	Hexachlorobenzene	
Chlordane-gamma	Bromomethane	Hexachlorobutadiene	
4-Chloroaniline	Butyl Benzyl Phthalate	~Indeno[1,2,3-cd]pyrene	
Chlorobenzene	Carbon Disulfide	Isophorone	
Ethyl Chloride (Chloroethane)	Carbon Tetrachloride	~Lead and Compounds	
Chloroform	Chlordane-gamma	Lithium	
	Chlorobenzene	~Mercury (elemental)	

Table C-5. Surface Soil Chemical Constituent Screening Results by Constituent (continued)

All Constituents with PRGs	Constituents where EPA RSL < PRG	Constituents where EPA RSL < PRG (any EU)	Constituents where MDC > EPA RSL (any EU)
Chloromethane (methyl chloride) 4-Chloro-3-methylphenol (Cresol, p-chloro-m-) ~2-Chloronaphthalene (Beta-) Chlorophenol, 2- Chlorpyrifos Chromium(III), Insoluble Salts Chromium(VI) ~Chrysene Cobalt Copper ~Cyanide (CN-) Cyclohexane DDD DDE, p,p'- DDT Dalapon Demeton ~Dibenz[a,h]anthracene Dibenzofuran Dibromochloromethane 1,2-Dibromo-3-chloropropane Dibutyl Phthalate Dicamba Dichlorobenzene, 1,2- Dichlorobenzene, 1,3- Dichlorobenzene, 1,4- Dichlorobenzidine, 3,3'- Dichlorodifluoromethane Dichloroethane, 1,1- Dichloroethane, 1,2- Dichloroethylene, 1,1- Dichloroethene, 1,2- (total) Dichlorophenol, 2,4- Dichlorophenoxy Acetic Acid, 2,4- Dichlorophenoxy)butyric Acid, 4-(2,4- Dichloropropane, 1,2- Dichloropropane, 1,3- Dichloropropene, cis-1,3- Dichloropropene, trans-1,3- Dieldrin Diethyl Ether (Ethyl Ether) Di(2-ethylhexyl)adipate Diethyl Phthalate Dimethoate Dimethylphenol, 2,4- Dimethylphthalate Dinitro-o-cresol, 4,6- Dinitrophenol, 2,4- Dinitrotoluene, 2,4- Dinitrotoluene, 2,6- di-N-Octyl Phthalate Dinoseb Dioxane, 1,4- ~TCDD, 2,3,7,8-	Chloroform Chloromethane (methyl chloride) Chlorpyrifos Chromium(VI) Chrysene Cobalt ~Cyanide (CN-) Cyclohexane DDD DDE, p,p'- DDT Di(2-ethylhexyl)adipate ~Dibenz[a,h]anthracene Dibenzofuran Dibromochloromethane Dichlorodifluoromethane Dieldrin Dimethoate Dimethylphthalate di-N-Octyl Phthalate Ethyl Acetate Ethylbenzene ~Fluorene Heptachlor Hexachlorobenzene Hexachlorobutadiene Hexachlorocyclohexane, Alpha- Hexachlorocyclohexane, Beta- Hexachlorocyclohexane, Gamma- (Lindane) Hexachlorocyclohexane, Technical Hexachlorocyclopentadiene Hexachlorodibenzo-p-dioxin Hexachloroethane HxCDD, 1,2,3,6,7,8- HxCDD, 1,2,3,7,8,9- ~Indeno[1,2,3-cd]pyrene Isophorone ~Lead and Compounds Lithium ~Mercury (elemental) Methyl Methacrylate Methyl tert-Butyl Ether (MTBE) Mirex ~Naphthalene Nitrobenzene Nitrosodiethylamine, N- Nitrosodimethylamine, N- Nitroso-di-N-butylamine, N- Nitroso-di-N-propylamine, N- Nitrosodiphenylamine, N- Nitrosopyrrolidine, N- Pentachlorophenol	~Naphthalene Nitroso-di-N-propylamine, N- Pentachlorophenol Styrene Thallium (Soluble Salts) Uranium (Soluble Salts) Xylenes	

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Table C-5. Surface Soil Chemical Constituent Screening Results by Constituent (continued)

All Constituents with PRGs	Constituents where EPA RSL < PRG	Constituents where EPA RSL < PRG (any EU)	Constituents where MDC > EPA RSL (any EU)
Diphenylhydrazine, 1,2- Diquat Endosulfan I Endosulfan II Endosulfan Sulfate Endosulfan (technical) Endrin Endrin aldehyde Endrin ketone Ethyl Acetate Ethylbenzene Ethylene dibromide (Dibromoethane, 1,2-) ~Fluoranthene ~Fluorene Fluorine (Soluble Fluoride) Glyphosate Guthion (Azinphos-methyl) Heptachlor Heptachlor Epoxide Hexachlorobenzene Hexachlorobutadiene Hexachlorocyclohexane, Alpha- Hexachlorocyclohexane, Beta- Hexachlorocyclohexane, Gamma- (Lindane) Hexachlorocyclohexane, Delta- Hexachlorocyclohexane, Technical Hexachlorocyclopentadiene Hexachlorodibenzo-p-dioxin HxCDD, 1,2,3,6,7,8- HxCDD, 1,2,3,7,8,9- Hexachloroethane ~Indeno[1,2,3-cd]pyrene Iron Isobutyl Alcohol Isophorone Isopropylbenzene (Cumene) ~Lead and Compounds Lithium Manganese (Diet) ~Mercury (elemental) Methoxychlor MCPA MCPP Methylene Chloride Methyl Methacrylate ~Methylnaphthalene, 2- Methyl Isobutyl Ketone (4-methyl-2-pentanone) 2-Methylphenol (Cresol, o-) 4-Methylphenol (Cresol, p-) Methyl tert-Butyl Ether (MTBE)	p-Nitrotoluene, Simazine Styrene Thallium (Soluble Salts) Toxaphene Uranium (Soluble Salts) Vinyl Acetate Vinyl Chloride Xylene, m- Xylene, o- Xylene, P- Xylenes		

Table C-5. Surface Soil Chemical Constituent Screening Results by Constituent (continued)

All Constituents with PRGs	Constituents where EPA RSL < PRG	Constituents where EPA RSL < PRG (any EU)	Constituents where MDC > EPA RSL (any EU)
Mirex			
Molybdenum			
~Naphthalene			
Nickel Soluble Salts			
Nitrate			
Nitrite			
Nitroaniline, 2-			
Nitroaniline, 4-			
Nitrobenzene			
Nitrophenol, 4-			
Nitroso-di-N-butylamine, N-			
Nitrosodiethylamine, N-			
Nitrosodimethylamine, N-			
Nitrosodiphenylamine, N-			
Nitroso-di-N-propylamine, N-			
Nitrosopyrrolidine, N-			
Nitrotoluene, p-			
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)			
Oxamyl			
Parathion			
Pentachlorobenzene			
Pentachlorophenol			
Phenanthrene			
Phenol			
Picloram			
~Pyrene			
Selenium			
Silver			
Simazine			
Strontium, Stable			
Styrene			
Sulfide			
Tetrachlorobenzene, 1,2,4,5-			
Tetrachloroethane, 1,1,1,2-			
Tetrachloroethane, 1,1,2,2-			
Tetrachloroethylene			
Tetrachlorophenol, 2,3,4,6-			
Thallium (Soluble Salts)			
Tin			
Titanium			
Toluene			
Toxaphene			
Trichlorobenzene, 1,2,4-			
Trichloroethane, 1,1,1-			
Trichloroethane, 1,1,2-			
Trichloroethylene			
Trichlorofluoromethane			
Trichlorophenol, 2,4,5-			
Trichlorophenol, 2,4,6-			
Trichlorophenoxypropionic acid, -2,4,5			
Trichloropropane, 1,2,3-			
Trichloro-1,2,2-trifluoroethane, 1,1,2-			
Trinitrotoluene, 2,4,6-			
Uranium (Soluble Salts)			
Vanadium and Compounds			

Table C-5. Surface Soil Chemical Constituent Screening Results by Constituent (continued)

All Constituents with PRGs	Constituents where EPA RSL < PRG	Constituents where EPA RSL < PRG (any EU)	Constituents where MDC > EPA RSL (any EU)
Vinyl Acetate Vinyl Chloride Xylene, P- Xylene, m- Xylene, o- Xylenes Zinc and Compounds			

Notes: First column lists all constituents for which WRW PRGs were developed. The constituents are arranged in the same order as they were in the CRA methodology document where the PRGs were developed (DOE 2004). The second column lists all constituents where the May 2016 EPA RSLs were lower than the WRW PRGs. The constituents are arranged in the order used in the PRG screening tables that were included in the CRA for each EU. That same order is used for subsequent columns. The third column includes all constituents that were carried through the screening process for any EU. The last column contains all constituents with a MDC that exceeded an EPA RSL. Note that arsenic and vanadium are not carried past the first column in this table because the EPA RSLs are greater than the WRW PRGs and rescreening isn't required.

Because no COCs were identified in the CRA for subsurface soils and because the reevaluation of surface soil data discussed above indicated that the CRA process was sound in identifying COCs, a less rigorous approach was taken in this FYR to answer Question B with regard to subsurface soils. An abbreviated PRG list was used for subsurface soil screening based on the results of the surface soil screening process. This included all constituents for which any surface soil MDC exceeded the surface soil PRG (constituents listed in Table C-4 and last column in Table C-5); tetrachloroethene was also added to this list as it was identified as a subsurface AOI in the RI/FS (Table C-1). The constituents evaluated along with screening results are listed in Table C-6. The current industrial soil RSLs were multiplied by 11.5 to obtain current estimates of subsurface WRW PRGs. The screening with this smaller set of PRGs proceeded in the same manner as the surface soil FYR evaluation described above.

Table C-6. Subsurface Soil Chemical Constituent Screening Results by EU

Constituent	IAEU	UWOEU	WBEU	NNEU	UWNEU	LWOEU	RCEU	LWNEU	IDEU	WAEU	SWEU	SEEU
2,3,7,8-TCDD												
Aroclor 1254	X											
Aroclor 1260												
Arsenic	X											
Benz[a]anthracene		X										
Benzo[a]pyrene	X	X	X									
Benzo[b]fluoranthene		X										
Chromium (VI)	X	X	X	X	X	X			X			
Cobalt		X										
Diben[a,h]anthracene	X											
Indeno[1,2,3-cd]pyrene												

Constituent	IAEU	UWOEU	WBEU	NNEU	UWNEU	LWOEU	RCEU	LWNEU	IDEU	WAEU	SWEU	SEEU
Lead and Compounds												
Mercury (elemental)												
Naphthalene	X											
Nitroso-di-N-propylamine, N-												
Tetrachloroethene												
Vanadium												
Uranium (Soluble Salts)	X											

"X" indicates MDC > EPA RSL
Shaded boxes indicate 95UCL > EPA RSL
Arsenic and vanadium were included in this table because they were identified as COCs in the CRA and 95UCL exceeds WRW PRG.

[Add Radiological Methodology]
In addition to human health risk calculations performed in the CRA, a radiation dose assessment for exposure to residual radionuclide contamination in surface soil and subsurface soil was also conducted. The dose assessment was conducted to demonstrate compliance with the annual dose limits in Colorado Radiation Control Regulations (Title 6 *Code of Colorado Regulations* 1007-1, Part 4 [6 CCR 1007-1, Part 4]), which was identified as an applicable or relevant and appropriate requirement (ARAR) in the RI/FS Report.

C2.4 Chemical Constituent Screening Results

Surface Soils. As was the case in the original CRA screening process, nearly all constituents were eliminated in this FYR evaluation based on the MDC comparison screen. Despite the lower EPA RSLs, the MDCs were typically much lower than the screening values. Very few constituents were retained by the RSL screen that were not also retained by the PRG screen. Among these is uranium, for which EPA has recently recommended a much lower toxicity value (EPA 2016), and chromium, which is discussed further below. Most constituents passing the RSL screen were subsequently eliminated based on the 95UCL comparison or following additional evaluation (e.g., frequency of detection [<5 percent]). Of the constituents evaluated in this FYR evaluation screening process, only four constituents passed through the 95UCL screen. These are summarized in Table C-7.

Table C-7. Chemical Constituents and EUs where 95UCL Exceeds Current Screening Level

Constituent	Exposure Unit											
	IAEU	UWOEU	WBEU	NNEU	UWNEU	LWOEU	RCEU	LWNEU	IDEU	WAEU	SWEU	SEEU
Arsenic	X		X									
Vanadium												
2,3,7,8-TCDD		X										
Benzo[a]pyrene	X	X		X	X							
Chromium (VI)	X	X	X	X	X	X	X	X	X	X	X	X
Diben[a,h]anthracene		X										

"X" means that the constituent would be considered a COC based on CRA screening methodology.
Shaded boxes differ with the CRA results.

As in the original CRA, dioxin was identified as a COC for the UWOEU and benzo(a)pyrene as a COC for the IAEU, UWOEU, and UWNEU. Based on the rescreening process, benzo(a)pyrene would also be considered as a COC for the NNEU, with concentrations slightly above the current RSL. The rescreening process also confirmed that arsenic is still considered a COC for the IAEU and WBEU based on current RSL concentrations; estimated risk levels associated with residual arsenic would be similar to that in the CRA. The arsenic 95UCL for all the other EUs also exceeded the PRG (and the current RSL) but arsenic was eliminated as a COC for those EUs in the CRA based on subsequent screens; it is assumed that the arsenic screening process is still valid for those EUs. Based on the current vanadium RSL, vanadium would not be a COC. The vanadium PRG is based on a lower toxicity value than is being used by EPA; however, vanadium is still undergoing study and this value could change in the future. As in the CRA, dibenz[a,h]anthracene did pass through the 95UCL screen for the UWOEU; however, the frequency of detection was less than 5% for this constituent and it was eliminated on that basis. For the most part, the rescreening process confirmed the results of the CRA.

The most significant result of the rescreening is that chromium passed the 95UCL screen for all EUs. This is because of a new toxicity value for chromium VI that EPA has adopted in its RSL tables. Chromium occurs in two major forms—chromium III and chromium VI—of which chromium VI is more toxic. Though most analyses at the site were for total chromium (which does not distinguish valence states), in order to be conservative, these results were treated as chromium VI in the screening process and the WRW PRGs were developed using toxicity data for chromium VI. The carcinogenic slope factor for chromium VI, which EPA has recently adopted in its RSL tables, results in a lower RSL than the noncarcinogenic PRG. The current EPA RSL is 6.3 mg/kg, compared with the noncarcinogenic WRW PRG of 28.4 mg/kg. The 95UCL total chromium values for all EUs exceed the chromium VI carcinogenic RSL.

There are, however, several factors that suggest this change does not have an impact on the protectiveness of the remedy. For one, chromium levels at the site do not appear to be appreciably different from background levels. Only total chromium was analyzed in background samples for the site. Background concentrations ranged from 5.5 to 16.9 mg/kg. The 95UCL surface soil values for all EUs are less than the upper threshold chromium concentration computed for background (the 99/99 upper tolerance limit of 22.21 mg/kg; DOE 1995). It is therefore likely that most of the chromium is naturally occurring.

Additionally, it is not clear whether chromium IV is present to a significant extent at the site. A small number of chromium VI analyses were performed for the IAEU (DOE 2006). Of these nine samples, chromium VI was detected in only one sample at 0.85 mg/kg. Therefore, much of the chromium is likely chromium III, which has a much higher screening level (EPA RSL of 125,000 mg/kg for unrestricted use).

Furthermore, the cancer slope factor included in the RSL table is a Tier III value (EPA 2003) in which there is considerable uncertainty. This slope factor has not been included in EPA's Integrated Risk Information System (IRIS), which is the preferred source of toxicity data for CERCLA sites. EPA continues to study chromium VI in order to develop a Tier I IRIS value. Finally, even if the chromium VI slope factor were applicable and chromium was designated as a site COC, the 95UCL values for residual surface soils would correspond to a risk level between 10^{-5} and 10^{-6} and would still be within the acceptable risk range.

Subsurface Soils. The MDCs for a number of constituents exceeded the revised PRG screening values. However, only chromium passed the 95UCL screen and would be considered a potential COC. As discussed above, a chromium VI slope factor was adopted by EPA in its RSL tables. If the lower EPA industrial soil PRG of 6.3 mg/kg was adjusted for subsurface soils, a resulting subsurface PRG would be approximately 72 mg/kg. The subsurface soil UCL for most EUs is below this value; however the 95UCL for chromium at the UWOEU and WBEU is higher. This is not expected to affect remedy protectiveness for the same reasons discussed above for surface soils. As was the case in the original CRA screening of subsurface soils, all other constituents dropped out based on the 95UCL screen.

The vapor intrusion pathway was identified in the CRA as a potentially complete pathway for VOCs in subsurface soils, including those at depths greater than 8 feet. Most of the AOIs identified for subsurface soils in the RI/FS are VOCs (Table C-1). EPA has finalized guidance for evaluating the vapor intrusion pathway (EPA 2015) and has provided guidance for evaluating this pathway in during five-year reviews (EPA 2012c). Updated toxicity data are also available for some VOCs that are identified as AOIs at subsurface depths > 8 ft (e.g., tetrachloroethene, trichloroethene). However, institutional controls are in place at the COU that eliminate the vapor intrusion pathway by prohibiting the construction of habitable structures. RAOs and cleanup goals remain valid and are not affected by updated guidance and toxicity data as long as institutional controls remain in place.

In addition to the toxicity values discussed above, EPA is reviewing the toxicity of two COCs for the COU—arsenic and benzo(a)pyrene. The arsenic study suggests that current methods of estimating risks from arsenic due to soil ingestion likely overestimate actual risks. The EPA study of benzo(a)pyrene (EPA 2014) is not yet completed and results cannot be cited at this time. Changes in slope factors may be forthcoming, but are not yet available. None of these additional studies affect the protectiveness of the remedy.

C2.5 Radionuclide Screening Results

[Add radiological review results for COU and POU.]

C3.0 OU3

[Add Radiological review results for OU3; there will not be a chemical discussion since all COCs for OU3 were radionuclides]

C4.0 References

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